Faraday Isolator

Low Power ISO Series User's Manual

Newport®

Experience | Solutions

Warranty

Newport Corporation warrants that this product will be free from defects in material and workmanship and will comply with Newport's published specifications at the time of sale for a period of one year from date of shipment. If found to be defective during the warranty period, the product will either be repaired or replaced at Newport's option.

To exercise this warranty, write or call your local Newport office or representative, or contact Newport headquarters in Irvine, California. You will be given prompt assistance and return instructions. Send the product, freight prepaid, to the indicated service facility. Repairs will be made and the instrument returned freight prepaid. Repaired products are warranted for the remainder of the original warranty period or 90 days, whichever is longer.

Limitation of Warranty

The above warranties do not apply to products which have been repaired or modified without Newport's written approval, or products subjected to unusual physical, thermal or electrical stress, improper installation, misuse, abuse, accident or negligence in use, storage, transportation or handling. This warranty also does not apply to fuses, batteries, or damage from battery leakage.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR USE. NEWPORT CORPORATION SHALL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, OR CONSEQUENTIAL DAMAGES RESULTING FROM THE PURCHASE OR USE OF ITS PRODUCTS.

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Newport Corporation Calling Procedure

If there are any defects in material or workmanship or a failure to meet specifications, promptly notify Newport's Returns Department by calling 1-800-222-6440 or by visiting our website at www.newport.com/returns within the warranty period to obtain a **Return Material Authorization Number (RMA#)**. Return the product to Newport Corporation, freight prepaid, clearly marked with the RMA# and we will either repair or replace it at our discretion. Newport is not responsible for damage occurring in transit and is not obligated to accept products returned without an RMA#.

E-mail: rma.service@newport.com

When calling Newport Corporation, please provide the customer care representative with the following information:

- Your Contact Information
- Serial number or original order number
- Description of problem (i.e., hardware or software)

To help our Technical Support Representatives diagnose your problem, please note the following conditions:

- Is the system used for manufacturing or research and development?
- What was the state of the system right before the problem?
- Have you seen this problem before? If so, how often?
- Can the system continue to operate with this problem? Or is the system non-operational?
- Can you identify anything that was different before this problem occurred?

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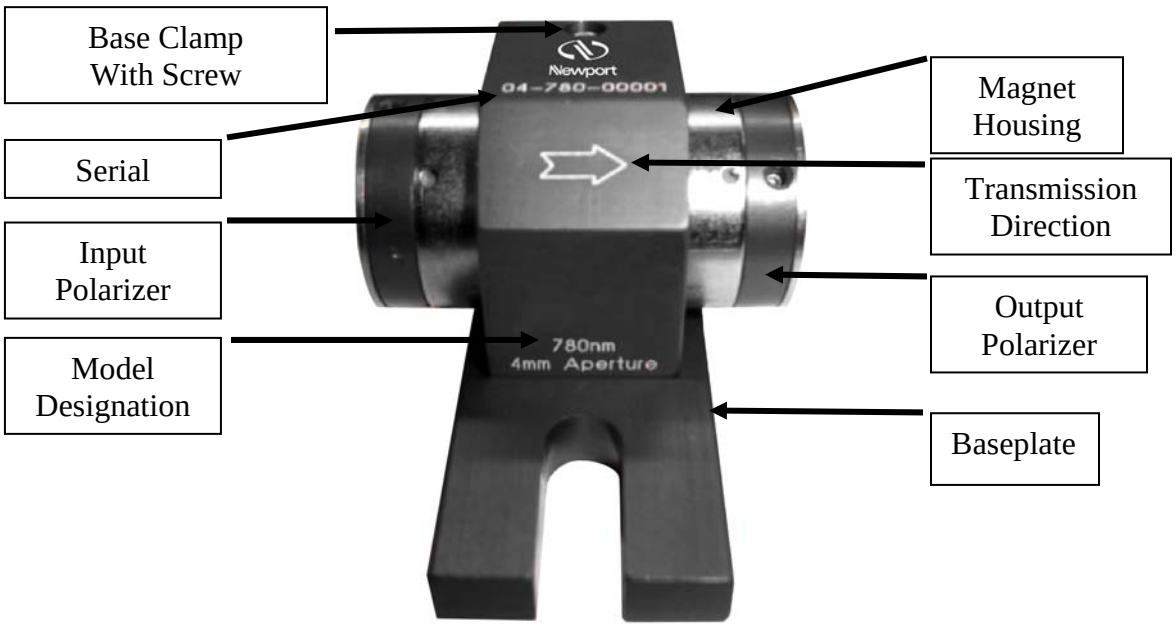
1 General Information

1.1 Introduction

Newport's Faraday Isolators are essentially a uni-directional light valve. They are used to protect a laser source from destabilizing feedback or actual damage from back-reflected light. Figure 1 below identifies the main elements of your Faraday Isolator.

Figure 1: Newport's 650-980 nm Low Power Faraday Isolator



The Faraday Isolator is a cylindrically shaped magneto-optic device. Strong Neodymium Iron Boron permanent magnets are used to generate high (>10,000 Gauss) axially oriented fields within the magnet housing. The strong longitudinal field causes 45 degrees of non-reciprocal polarization rotation for propagating light via the Faraday Effect in the terbium gallium garnet ("TGG") crystal located within the magnet housing. In operation, the magnet housing is sandwiched between input and output polarizers that have their transmission axes oriented 45 degrees relative to each other to account for the 45 degrees of Faraday Rotation in the TGG crystal in the forward (transmission) direction. In the reverse (isolation) direction, the non-reciprocal Faraday rotation and the

45 degree polarizer transmission axis angle add so that the polarization transmitted by the output polarizer is rejected at the input polarizer.

Your Newport Faraday Isolator is labeled with a serial number on the base clamp of the device.

1.2 Safety

The operational hazards presented to operating personnel by the use of your Newport Faraday Isolator are listed below. An explanation of how the Faraday Isolator is designed, together with procedures users can employ to eliminate or minimize these hazards is presented in italics.

1. Danger of sharp ferromagnetic objects being attracted to the residual permanent magnetic fields outside of the Faraday Isolator.

   Your Newport Faraday Isolator requires strong internal magnetic fields to operate properly. Efforts have been made to minimize external fields from the device while still maintaining a relatively small and cost effective package. The external fields are designed to be well within Federal safety guidelines which limit external fields from magnetic devices to be less than 2KGauss at a radial distance of 5cm from the outside of the device. However, such fields can be sufficient to attract nearby objects such as knives and razor blades. Should attraction of such objects begin to occur there would be a strong attractive force directing these objects towards the interior of the magnet housing. This could be particularly likely to result in injury (e.g. a cut or puncture wound) if such attraction occurred while the device was being handled –particularly if a body part of the operating personnel is near a beam Aperture (i.e. end) of the device.

   To minimize the above risks remove all loose ferromagnetic objects from the path over which your Newport Faraday Isolator is to be moved prior to attempting to move it. **Do not** pick up the isolator by its ends (i.e. apertures) where the attractive magnetic fields are strongest. Always pick the isolator up along its sides.

2. Failure of operating personnel to observe standard laser safety by sighting down through the Faraday Rotator when laser radiation is present.

   The optical elements within the Newport Faraday Isolators can be transmissive throughout the visible and near infrared. Consequently it is never appropriate to view through the device in either the transmission or isolation direction when laser radiation is present –even with laser safety goggles.

<u>Never</u> sight through your Newport Faraday Isolator in either direction when there is <u>any possibility</u> of laser radiation being present.

3. Harm caused by external magnetic fields.

Your Newport Faraday Isolator has been designed to meet existing Federal safety guidelines for external fields as noted previously. Such guidelines could change in the future as more information becomes known or reviewed regarding the interaction between magnetic fields and human health. Since there exist various claims regarding the potential harmful (and beneficial!) effects of magnetic fields on humans it is prudent to limit interaction with these fields as much as possible.

Personnel with any magnetically sensitive implants such as pacemakers should consult their medical doctor regarding any potential complications which could arise from the isolator external magnetic fields.

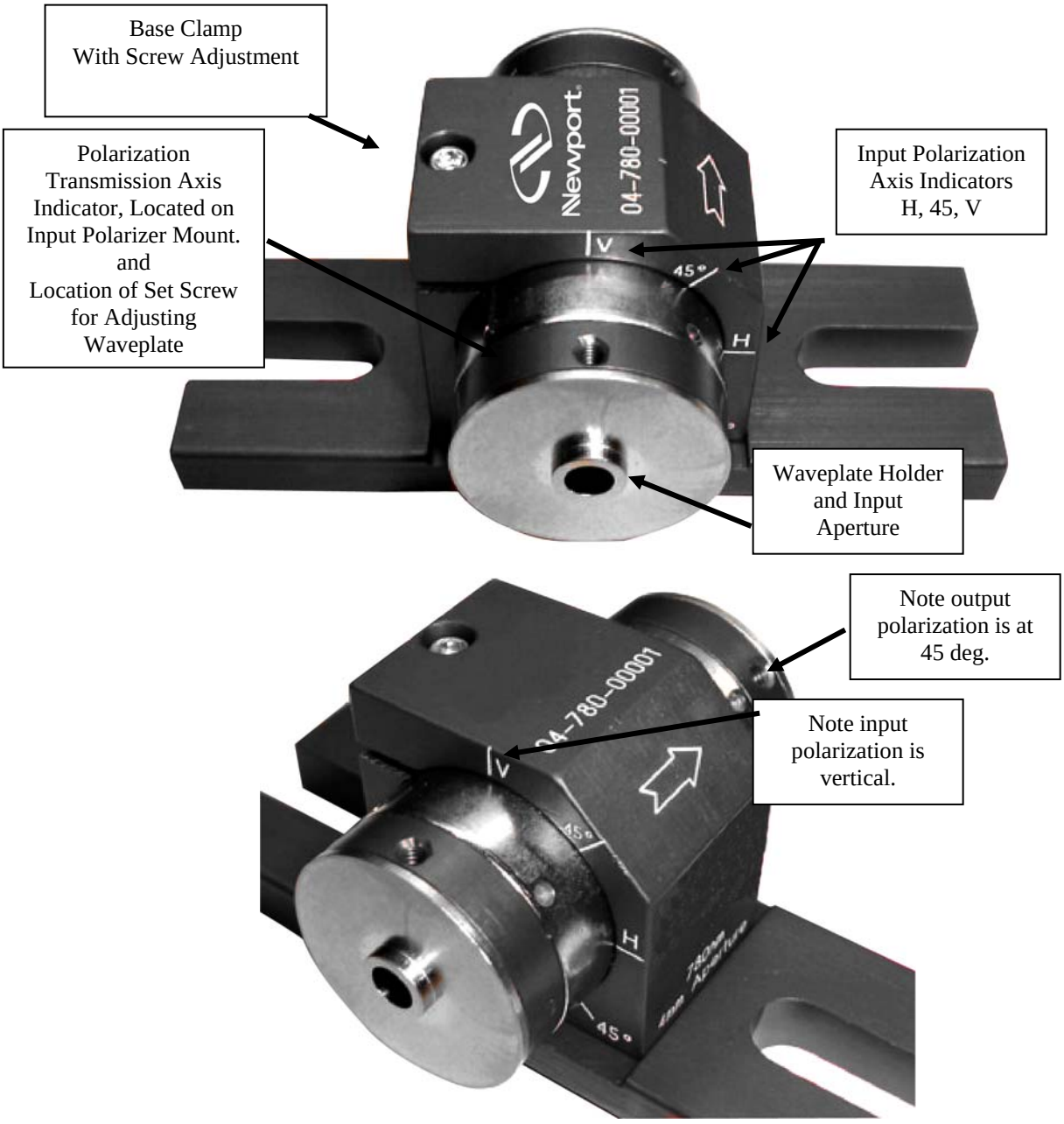
4. Other non-health related hazards.

The Faraday Isolator external magnetic fields can draw ferromagnetic objects into the magnet housing that can damage the optical elements within the device. Keep a suitable area in all directions around the Faraday Isolator clear of any loose ferromagnetic objects. Ideally, use non-magnetic tools (such as 300 series stainless steel or titanium) and hardware to secure the Faraday Isolator. If only ferromagnetic tools are available use extreme care when using them around the Faraday Isolator. It is always helpful to bring such tools towards an aperture (or end) radially rather than along the optical beam path. Doing this ensures that the fields will tend to pull such objects into the magnet housing endplate rather than into the optical aperture. Where possible use two hands, one to hold the tool and the other to guide it to the desired destination.

Another concern regarding external magnetic fields is their effect on magnetically sensitive devices. The external fields are strong enough to induce a pulse of current in electronic devices (such as digital watches) that can destroy them. The fields can also disrupt the operation of other mechanical devices with ferromagnetic parts in them. Finally, the external fields can erase information from magnetic strips such as are found on credit and ID cards. Remove all magnetically sensitive materials and devices such as watches, computer hard drives and magnetic strips from operators prior to working in the proximity of an isolator.

1.3 Operation

Figure 2: View of Faraday Isolator and Tuning Features.



The low power Faraday Isolator uses dichroic sheet polarizers at both the input and output of the device. These broadband polarizers absorb the rejected transmission and are therefore only effective for low power applications. The inscribed arrow on the baseclamp displays the transmission direction. The output polarizer is seen to be oriented with its transmission axis rotated 45 degrees relative to the input polarization. The input polarization shown is vertical. The central magnet housing together with the TGG crystal residing in its center forms a Faraday Rotator. The Faraday Rotator rotates the input transmission axis by 45 degrees so that transmitted light has a polarization aligned with the output transmission axis. The input and

output polarizers work in conjunction with the central Faraday Rotator to form a Faraday Isolator. Though the overall size of the device varies depending on the model, the operation of the polarizer mounts are identical.

Figure 3: Horizontal Input Polarization

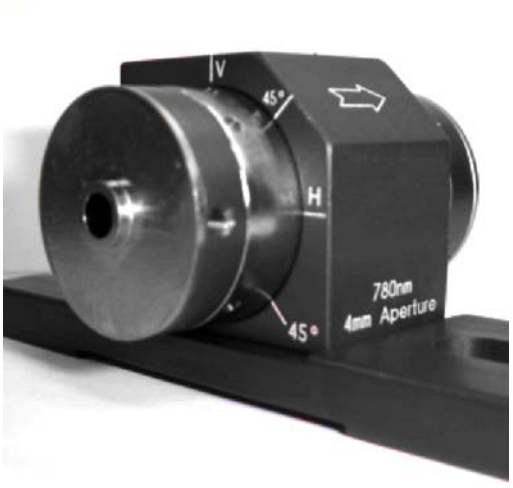
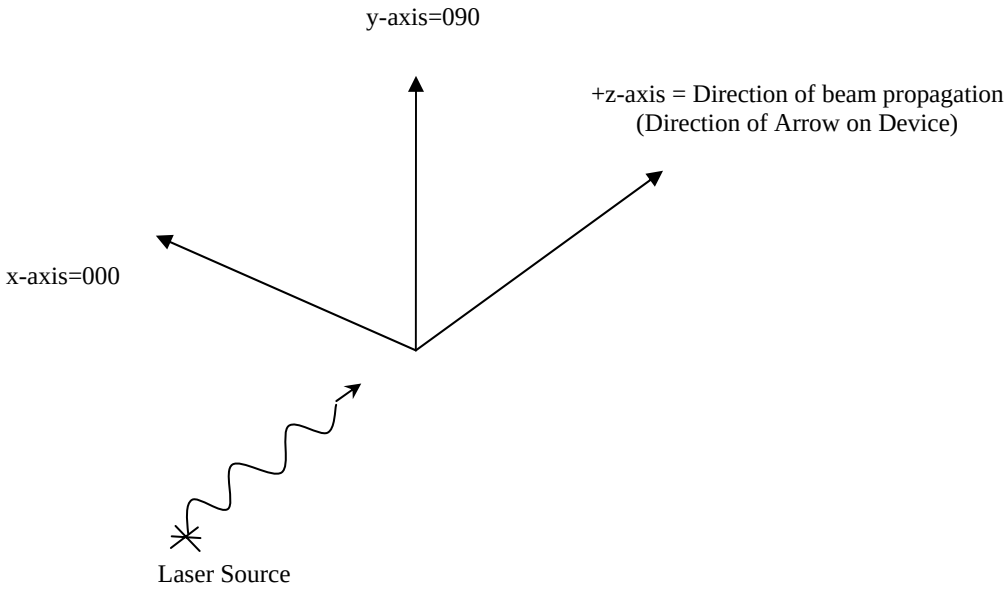


Figure 4: Vertical Input Polarization

Figure 3 shows a device aligned for a horizontal input polarization. The screw-hole located on the side of the polarizer mount indicates the approximate angular position of the polarizer transmission axis and maximum transmission is observed when the input polarization is aligned to this angle, the default orientation is horizontal.

Figure 4 shows a device aligned for a vertical input polarization, with the transmission axis rotated 90 degrees with respect to that depicted in Figure 3.



1.3.1 Using your Faraday Isolator

Observe the guidelines for safe use of your Faraday Isolator found in Section 1.2 above when removing your isolator from its shipping container. Do not remove the protective dust-cover endcaps from the polarizers until the device is in a clean, relatively dust free environment. Save the protective endcaps, packaging material and containers in the event that the device should ever need to be returned to Newport.

Verify that the Input and Output polarization states are consistent with the intended mode of operation. If not, re-adjust the isolator as required (see Section 1.3.2).

With the source laser off, or running at very low power (less than 100mW), position the Faraday Isolator such that the source laser beam can be directed through the Input Aperture.

Critical alignment of the Faraday Isolator should be done at low power (less than 100mW) in order to prevent optical damage to your isolator or laser source.

Use IR cards or viewers to ensure that the source laser beam is centered on the input and output apertures. The clear aperture of this device is 4mm, centered on the circular cross section of the magnet body. There are different mounting options for establishing appropriate beam height. It is also preferable to use an IR viewer to ensure that weak reflections from AR coated optical surfaces in the Faraday Isolator are not being directed back into the source laser. The optical surfaces in the Faraday Isolator are angled slightly to reduce these reflections. Increasing the

distance between the Faraday Isolator and the source laser can also help ensure that no reflections couple back into the source laser if necessary. Alternatively, if the beam used is smaller than the aperture of the device by a reasonable margin, the device may be slightly tilted.

At this point, the Faraday Isolator should be secured to the work surface with two (2) ¼ - 20 or M6 screws –one for each slot in the baseplate flanges. Alternatively, the baseplate may be removed from the baseclamp by removing two 8-32 screws on the bottom side of the baseplate. Then, the baseclamp/isolator assembly may be mounted to a standard laboratory post with an 8-32 set screw or may be conveniently mounted into laser systems, minimizing the required footprint of the device. Steel (ferromagnetic) ball drivers or other such wrenches will be attracted to the external magnetic field surrounding the device. If possible, use anti-magnetic stainless steel or titanium tools. If ferromagnetic tools are used, it is desirable to introduce them slowly towards the device from the sides along the direction of the baseplate flange slots.

One important consideration is that this isolator is intended to be used at low power. The device is very compact given the physical size of the polarizers used in its construction. One drawback of this is that the rejected power is absorbed in the polarizers themselves and therefore damage thresholds are limited to 25W/cm^2 CW.

1.3.2 Tuning your Faraday Isolator

A. *Adjusting Input Polarization*

The transmission axis of the input polarizer is indicated by the radial position of the screw hole located on the input polarizer mount. If the linear polarization of the laser source is geometrically known, aligning the input polarization of the Faraday Isolator to that of the laser source is straightforward. Simply loosen the #2-56 socket head Baseclamp Screw in the Baseclamp until the magnet housing rotates freely. Continue to rotate the magnet housing until the Input Polarizer transmission axis is aligned to that of your laser source. Following alignment procedures, rotating the magnet body inside the clamp until maximum transmission is observed through the isolator will indicate that the input polarization is parallel to the input polarizer axis. Then re-tighten the Baseplate Clamp Screw.

B. *Fine Wavelength Adjustment*

Each of the 650, 780, 850, and 980 nm isolators may be tuned over the wavelength range specified in section 1.4. Tuning is achieved by adjusting the relative angle between the input and output polarizers. For wavelengths longer than the central wavelength, the faraday rotation is less than 45 deg., for wavelengths shorter than the central wavelength, the faraday rotation is more than 45 deg. and therefore, the device may be tuned for maximum extinction with a small transmission loss, illustrated by the wavelength tuning curves in section 1.4. The 3dB bandwidth of the isolators ranges from 12 nm at 650 nm

to 20 nm at 980nm, in increasing value. For maximum extinction, manually tune the device to the appropriate wavelength.

With the source laser operating at an average power of 100 mW or less (attenuate the beam if necessary to achieve such a low power level) direct the source laser beam through the Faraday Isolator in the reverse direction –through the Output Polarizer first and then through the Input Polarizer. Use an IR viewer to view the transmitted radiation to ensure that it is directed onto a Power Meter. The Power Meter should be sensitive enough to detect power levels below 0.01mW (or 40dB of the input signal used). As a reference, 40 dB is a factor of 1:10000 and 10dB is a factor of 1:10. If necessary, loosen the Baseplate Clamp Screw to allow the Output Polarizer transmission axis to be rotated parallel to the source laser polarization axis. Re-tighten this screw when complete.

Loosen the button head Input Polarizer Clamp Ring screws just enough so that the Input Polarizer Mount may be rotated (the Input Polarizer is opposite to the laser source at this point). Rotate the Input Polarizer Mount until a minimum reading is indicated on the Power Meter. Re-tighten the Input Polarizer Clamp Ring Screws. The minimum reading should be at least 30dB (1:1000) of the input signal. If not, call Newport for assistance (see Section 2 below). The Faraday Isolator is now optimized to operate at the new laser source operating wavelength. It may now be installed for operation in transmission with the laser source as per Section 1.4 and the procedure outlined in Section 1.3.2 A.

C. *Waveplate Option and Adjustment*

It is possible to order a Faraday Isolator with a half-waveplate on the output. Should any of the above adjustments become necessary, or if the desired output polarization changes, the waveplate will need to be adjusted. To re-align the waveplate loosen the radially oriented set-screw in the output polarizer mount and rotate the waveplate until the desired output polarization is achieved. Re-tighten the waveplate set-screw. Do not over-tighten. A waveplate may also be used in the input of the device if necessary.

1.4 Specifications

Model	Center Wavelength (nm)	Tunable Range (nm)	Isolation (dB)	Trans. (%) (see note 1)	CW Damage Threshold W/cm^2
ISO-04-980-LP	980	960-1030	30-38	>90	25
ISO-04-850-LP	850	840-960	30-38	>88	25
ISO-04-780-LP	780	740-840	30-38	>82	25
ISO-04-650-LP	650	630-700	30-35	>75	25

Two-Stage Option

Faraday Isolators may be used in series to obtain 60+dB isolation, mounted on a common baseplate.

Mounting Options

Magnet housings are inserted into a clamping device that provides 8-32 screw holes and may be mounted onto a standard post. All devices include a base for mating with a standard English breadboard (1/4-20 screw holes on 1" spacing).

Notes

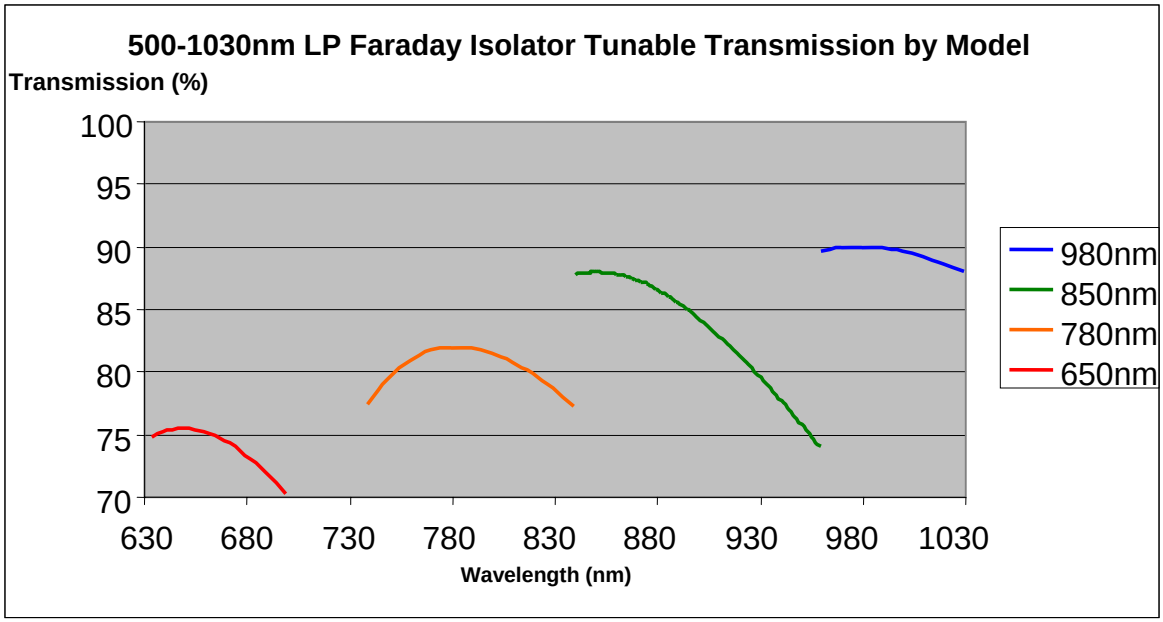
1. **Transmission**: This is measured from the center wavelength. Tunable transmission will be wavelength dependent. Please consult the spectra below.

2. **Damage Threshold:** Damage threshold is limited by cemented optics and broadband AR coatings for wavelength tunability, for higher damage threshold applications, please contact Newport.

3. **Operating Temperature:** Performance of Newport's Faraday rotators/isolators is related to operating temperature. For information on the effect of operating temperature on Newport's Faraday rotators/isolators, please review our technical bulletin, **Effects of Temperature on Newport's Faraday Rotators/Isolators**

4. **Center Wavelength:** This refers to the wavelength specified for 45 +/-2 deg and is not necessarily the median of the wavelength range.

5. **Tunable Transmission:** The below graphs show the transmission of the device following tuning as per instructions in section 1.3.2 B.


500-1030nm LP Faraday Isolator Tunable Transmission by Model
Transmission (%)
100
95
90
85
80
75
70
630
680
730
780
830
880
930
980
1030
Wavelength (nm)
980nm
850nm
780nm
650nm

2 Factory Service Information

2.1 Service Form

Newport Corporation
U.S.A. Office: 800-222-6440
FAX: 949/253-1479

Name_____ Return Authorization # _____
(Please obtain RA# prior to return of item)

Company _____

Address _____ Date _____

Country _____ Phone Number _____

P.O. Number _____ FAX Number_____

Item(s) Being Returned:

Model # _____ Serial # _____

Description _____
_____
_____
_____
_____
_____

Reason for return of goods (please list any specific problems):
_____
_____
_____
_____
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_____
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Notes:

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